Planning a Smart Grid Transition: What comes after the meter?

Michigan Smart Grid Collaborative
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Objectives

1. Developing a Smart Grid Vision
2. Ongoing Smart Grid Research
3. Planning a Smart Grid Transition

Objectives

1 **Developing a Smart Grid Vision**

There are many visions *

Regulator	Utility	Customer
Cost Effectiveness, Economic Harmony, Equity	Cost Recovery	Value, Privacy

- ***..expand the infrastructure for moving electricity from where it is generated to where it is needed***
- ***..accommodate distributed energy from local areas and,***
- ***Make the grid 'smart' so that it can monitor and balance the load,***
- ***..capitalize on a massive national fleet of clean plug-in cars.***

* Al Gore's 'Unified Smart Grid' vision for repowering the USA - will it happen?, November 8, 2008, http://blogs.zdnet.com/collaboration/?p=160

Basic Questions

1. What problem(s) are you trying to solve: manage future costs, improve reliability, or integrate renewables ?
2. Which customer(s) are you trying to serve: society, end-user (rate payer), or the utility ?
3. How is the "Smart Grid" different from what you've already been doing ?
4. What are the smart grid costs and benefits of implementing Smart Grid?
5. Where do you start and what information do you need to proceed: [1] Pilot programs or [2] a Transition Plan ?

Societal Benefits ?

	Claimed Societal Benefits	Attribute	Realistic ?
1	Dramatic reduction in tailpipe emissions	1-6	?
2	Reduction in petroleum imports of >50%	1-5	?
3	Reduction in peak loads – lowering prices for consumers	2, 3, 5	?
4	Improved grid reliability	4-6	?
5	Increased grid security	4-6	?
6	Positive environmental impact	1-7	?
7	Enable new products, services and competitive retail markets	3	?
8	Anticipate and respond to system disturbances (self-heal)	4-6	?
9	Perform continuous self-assessment, respond faster by supplementing human operators.	4-6	?
10	Operate resiliently against attack and be less vulnerable to natural disaster	4-6	?

1. PHEV's 2. Advanced Metering 3. Dynamic Rates 4. Sensing
5. Automation 6. Expert Systems 7. New Technology

Consumer Benefits ?

	Claimed Consumer Benefits* (slide 15)	Attribute	Realistic ?
1	Equivalent of $1.00 per gallon for gasoline	1	?
2	Provide prices and opportunity to buy when KWh prices are low and sell when high	2-7	?
3	Home back-up power and mobile resource	1, 2-7	?
4	Protecting against power losses and avoiding costly interruptions and spoilage	2-7	?
5	Reducing the cost of electricity during peak power periods,	2-3	?
6	Customer choice from products to services	2, 3	?
7	Enhanced system reliability	2, 3	?
8	Enable active participation by consumers	2, 3, 5, 7	?
9	power quality at different prices	2, 3, 5	?
10	Consumers access to information, control and options that allow them to better manage energy and environmental costs	2, 3, 5, 7	?

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Utility Benefits ?

Claimed Utility System Benefits* (slide 15)		Attribute	Realistic ?
1	Minimizing energy transmission losses	7	?
2	Improving the efficiency of the electricity grid.	2-7	?
3	Increased efficiency of power delivery	2-7	?
4	Extended asset life	?	?
5	Seamlessly integrate generation and storage options	[2,3,5] [4-7]	?
6	Operate efficiently to improve load factors, lower system losses, and improve maintenance.	[2,3,5] [4-7]	?
7	Grid operators have new resource options to provide energy, capacity and ancillary services	[2,3,5] [4-7]	?

1. PHEV's 2. Advanced Metering 3. Dynamic Rates 4. Sensing
5. Automation 6. Expert Systems 7. New Technology

Sources
1. The Smart Grid – Benefits and Challenges, EEI Annual Convention, J.Miller – Modern Grid Strategy Team, June 16, 2008
2. What will the Smart Grid Look Like ?, A Vision for the Smart Grid., DOE Office of Electricity Delivery and Energy Reliability, June 2008.
3. Miscellaneous public reports, press releases, presentations, and private sources.

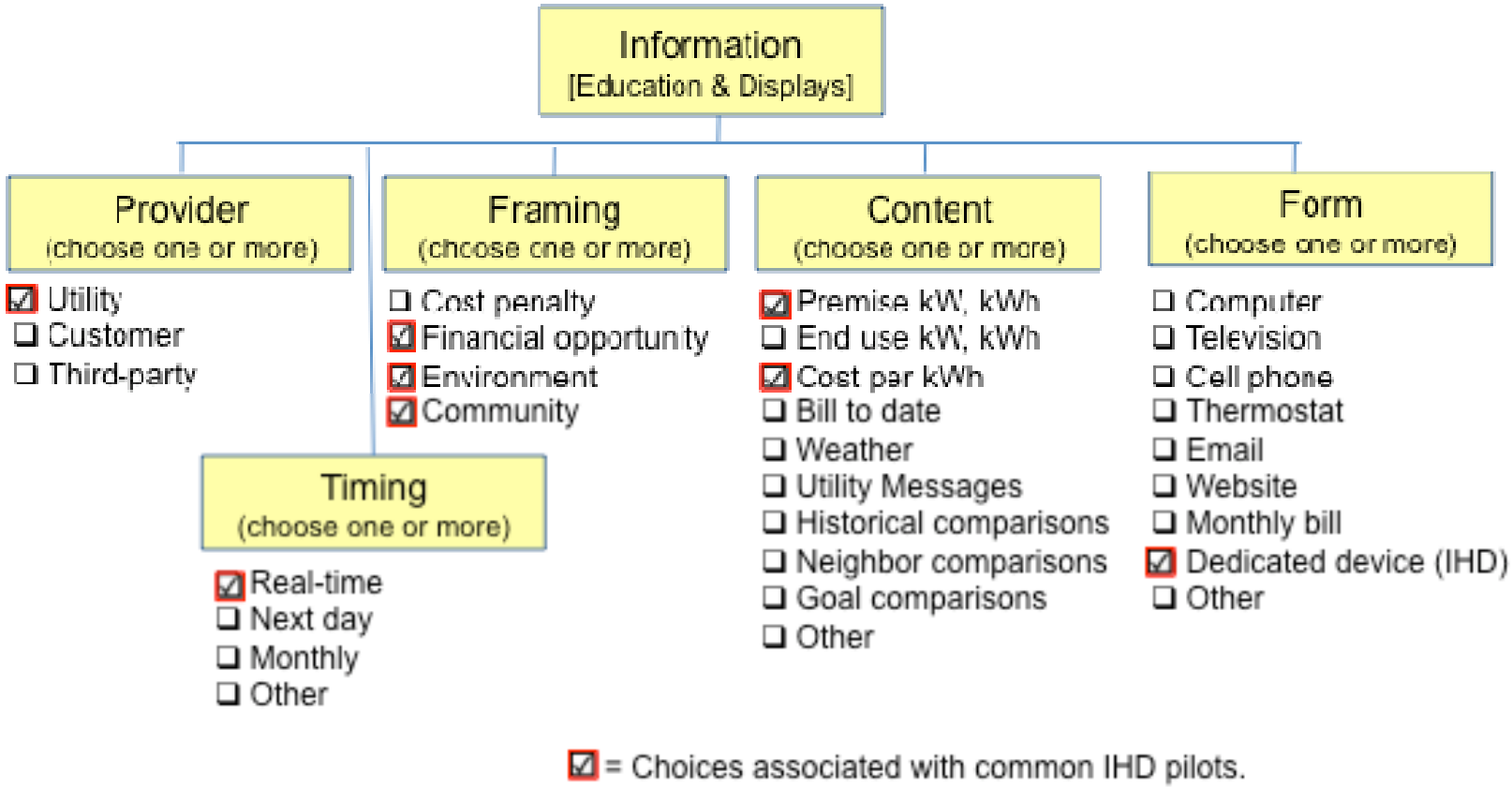
2 Ongoing Smart Grid Research

Pending Consumer Behavior Pilot Research

150,000 customers are expected to "participate" as treatment or control customers in ~10 DOE SGIG-funded projects involving AMI, dynamic pricing and consumer behavior studies

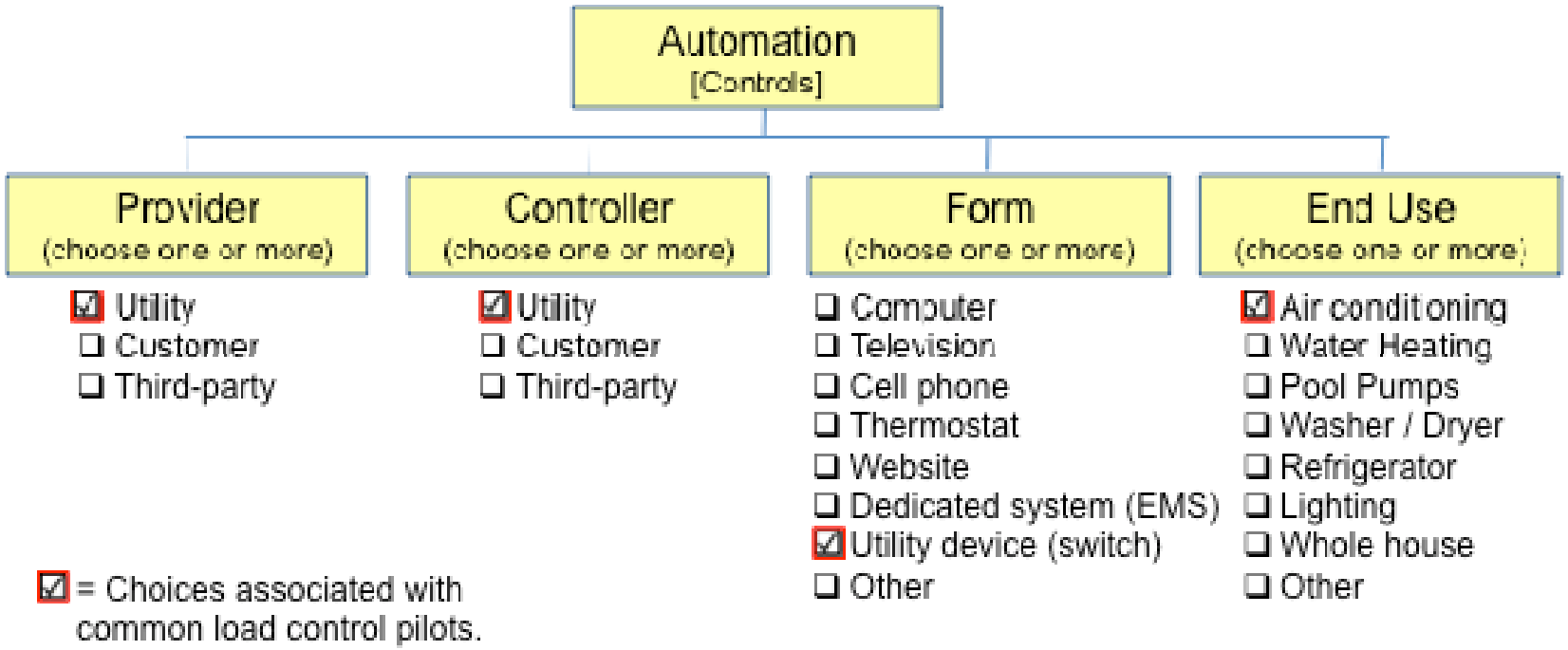
	Sierra Pacific	Nevada Power	OG&E	MMLD	CVPS	VEC	MN Power	CIC	SMUD	DECo	Total
Rate Treatments											
TOU	●	●							●		3
CPP	●	●	●	●	●		●		●	●	8
CPR					●			●			2
VPP			●			●					2
Non-Rate Treatments											
Education	●	●									2
Cust. Service						●					1
IHD	●	●	●		●	●	●	●	●	●	9
PCT			●					●		●	3
DLC								●			1
Features											
Bill Protection	●	●	●	●							4
Experimental Design											
Opt In	●	●	●	●	●	●	●		●	●	9
Opt Out								●	●		2
Sample		**16,400**	**5,250**	**500**	**3,700**	**1,500**	**4,000**	**5,000**	**57,000**	**6,200**	

Prior Information Feedback Research*



* Figure 1. Information Options, DOE Smart Grid Investment Grant, Technical Advisory Group Guidance Document #2, Non-Rate Treatments in Consumer Behavior Study Designs, August 6, 2010.

Prior Automation and Control Research



* Figure 1. Information Options, DOE Smart Grid Investment Grant, Technical Advisory Group Guidance Document #2, Non-Rate Treatments in Consumer Behavior Study Designs, August 6, 2010.

3 Planning a Smart Grid Transition

Plan for a Transition: What are the issues?

1. How do we transition customers from existing flat and tiered rates to a dynamic rate?
2. How do we educate customers regarding both the opportunities and risks?
3. Will technologies be available so customers can automate their response?
4. What can we do to identify potential adverse bill impacts and customer resistance and mitigate problems before they occur?

1 Rate Transition Options

How do we transition customers from existing flat and tiered rates to a dynamic rate?

❑ Time Frame Issues:

- Education: [Virtual Participation] familiarize customers with rate structure and prices before rate introduction – minimum 6-12 months.
- Education: need to provide continuing information on adaptation methods and technologies – ongoing.
- Technologies: 3-5 year minimum acquisition cycle for low cost adaptation options
- Technologies: 4-9 year minimum acquisition cycle for major appliance and infrastructure options

❑ Rate Design considerations / options

- Transition from “safe” PTR to dynamic CPP.
- Phase in dynamic rate price differentials over a 3-5 year period.
- Opt-out options to hedged flat or TOU rate.

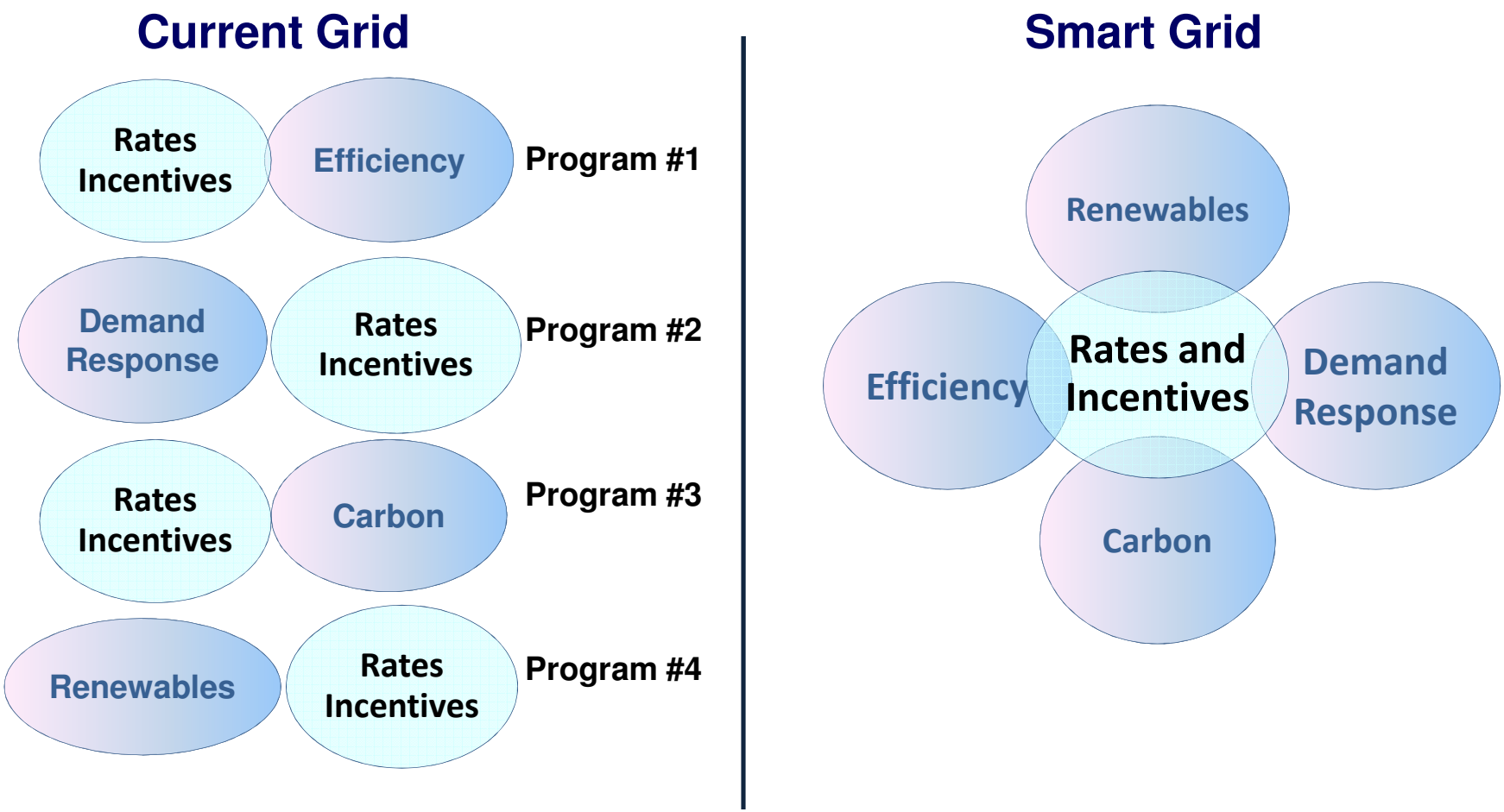
Rate Transition Issues

1. When to consider implementation?
2. Rate Design as a tool to integrate EE, DR, and renewables.
3. What type of Rate Design: Basic Service or Product Overlay?
4. Opt-in or Opt-out participation?
5. Low Income /Senior Bill Impacts
6. What do we know – is PTR really a safe transition option?
7. What don't we know?

1. When to consider implementation ?

- **Do nothing – let others resolve the uncertainties**
  - Wait for FERC to resolve design and DR incentives
  - Let the wholesale ISO/RTO define DR products for retail customers
  - Wait and observe the DOE-funded ARRA Smart Grid Investment Grant Consumer Behavior Studies
- **When to begin planning – Factors to consider:**
  - Do you have pending state mandates (renewable portfolio standards)?
  - Do your customers want to take advantage of smart appliances?
  - Do you anticipate a growing penetration of electric vehicles?
  - Earlier preparation and planning might mitigate potential problems and minimize lost opportunities

2. Integrating EE, DR, and renewables?



2. Integrating EE, DR, and renewables?

Rate Forms - Compatibility

	Non-Dynamic Rates		Dynamic Rates		
Initiatives	**Tiered**	**Time of Use**	**Peak Time Rebate**	**Critical Peak Price**	**Real Time Price**
Efficiency	**No**	**No**	**No**	**Yes**	**Yes**
DR (1) – Reliability, (Day Ahead)	**No**	**No**	**Yes**	**Yes**	**Yes**
DR (2) –Congestion Mgmt, Ancillary services (Day of)	**No**	**No**	**No**	**Yes**	**Yes**
Solar PV	**No**	**Yes**	**No**	**Yes**	**Yes**
Storage	**No**	**Yes**	**No**	**Yes**	**Yes**
PHEV / EV	**No**	**Partial**	**No**	**Yes**	**Yes**
Carbon Management	**No**	**Partial**	**No**	**Yes**	**Yes**

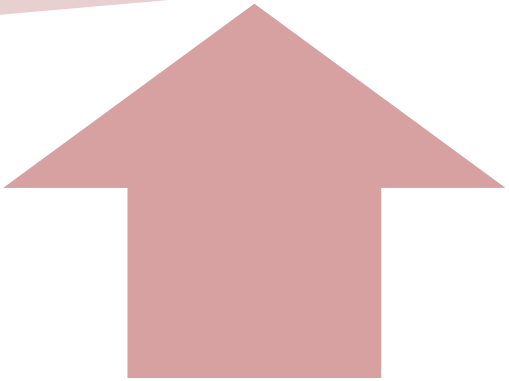
3. What type of Rate Design ?

Basic Service

- **Pros**: Offers greatest potential for economic efficiency gains
- **Cons**: Will be more difficult due to conflicting regulatory goals (bill impacts)

Product Overlays

- **Pros**: Can design the overlay without having to re-design the underlying rate for basic service
- **Cons**: Will have more limited potential for improving overall economic efficiency



4. Opt-in or Opt-out participation ?

- **Mandatory Rates (new default rate, no opt-out)**
  - **Pros:** Likely to achieve the largest overall economic benefits
  - **Cons:** Potential for windfall gains and losses and customer opposition
- **Mandatory Assignment (with an Opt-out provision)**
  - **Pros:**
    a) **"Nudges" people onto more efficient rate structure,**
    b) **Preserves customer choice , and**
    c) **Reduces marketing and recruitment costs**
    d) **Creates larger potential market to enable smart appliances, energy management options, and competitive pricing**
  - **Cons: might have customers migrate in larger numbers if prices change**
- **Voluntary Rates (Opt-in or voluntary participation)**
  - **Pros:** Reduces potential windfall losses and customer opposition.
  - **Cons:**
    a) **Self-selection bias and potential moral hazard issues.**
    b) **Adverse impact on cost effectiveness for metering and DR**

5. Low Income / Senior Bill Impacts?

- Impacts can be modeled in advance
- Resistance may be a function of customer education, uncertainty, and clear mitigation options
- Rate design can be structured with efficiency, appliance rebates, other programs and policy initiatives to provide mitigation options.

6. What do we know?

- Customer who have not participated are skeptical and concerned about rate and bill volatility.
- Most customers who have participated like and understand the rate,
- The vast majority of customers save money
- Vast majority want to continue on the rate and think it should be offered to all customers.

7. What don't we know ?

- Will customer response behavior persist or erode over time?
- How can the results from utility pilots or demonstrations be extrapolated to other regions with a different climate, economics, or customer mix?
- What types of education, communication, and enabling technology will work best to improve customer response?
- Will more pilots address unresolved issues or is a staged implementation a better approach?
- Will long-term impacts compare to short-term impact?

2 Education Transition Options

How do we educate customers regarding both the opportunities and risks ?

- **Pre-Rate Introduction - Shadow Bills [Virtual Participation]**
  - Provides customers with side-by-side comparison of potential bill impacts
  - Can be supplemented with adaptation and technology information to address opportunities and mitigation
- **Post-Rate Introduction (ongoing)**
  - Web-based tools and information
  - Case studies to illustrate adaptation
  - Technology reviews, case studies, incentives
  - Shadow bills, cumulative accruing impacts to provide post implementation (purchase) confirmation

What are you trying to accomplish ?

Customer Feedback Objectives[8]

Behavioral Change

- Program thermostat
- Turn off lights
- Shorter showers
- Fewer wash loads
- Unplug electronics

Short –term, low cost, quick decisions, real-time feedback, Price

Adaptation

- Plant shade trees
- Weather strip
- Install CFL lights
- Install timers

Near–term, medium cost, lengthy decisions, multiple info sources, automation

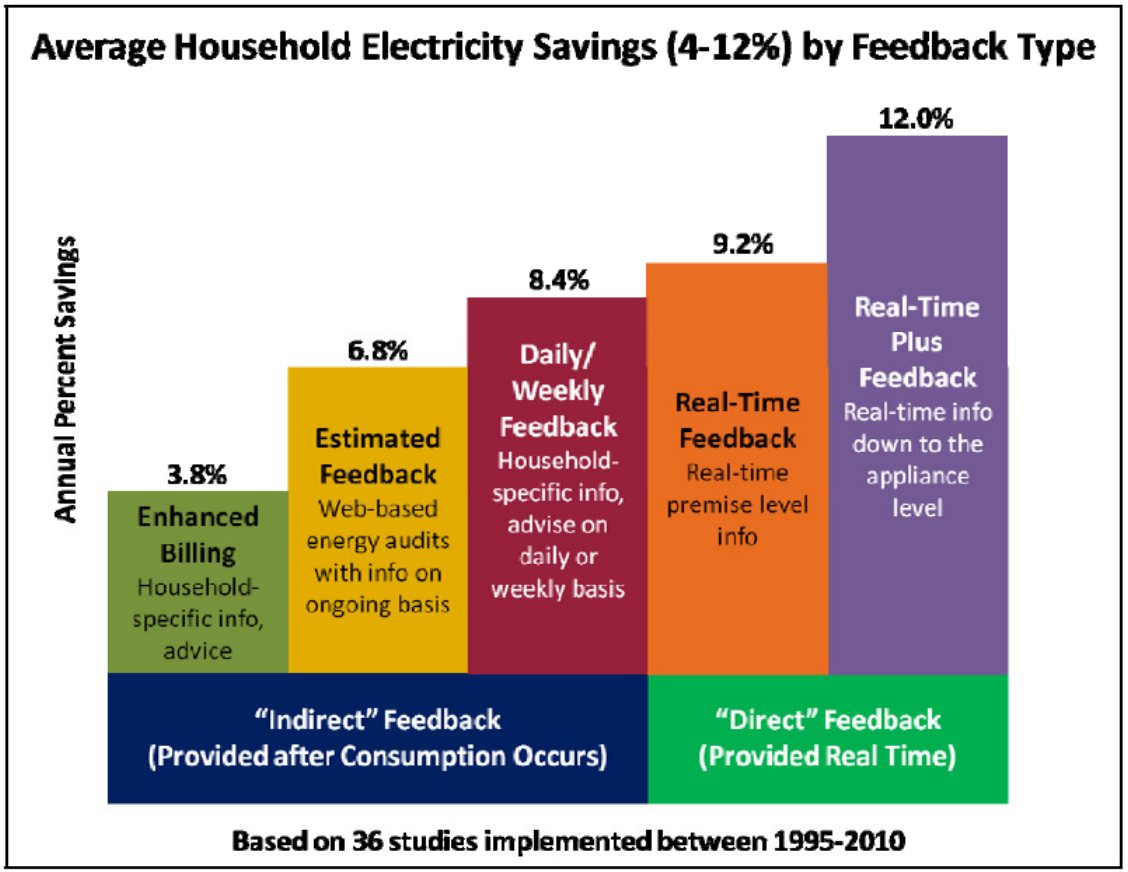
Infrastructure Change

- High-efficiency appliances
- Replace windows
- Insulate walls
- Insulate ceilings
- Install Solar PV

Long–term, high cost, protracted decisions, multiple info sources, subsidies, incentives

ACEEE: Feedback Effectiveness – Is there a disconnect ? [2]

The Summary Says…



But the text says …

"..these estimates are dominated by studies with small sample sizes and short duration: further studies with large sample sizes and longer duration are needed before conclusions can be drawn." [2]

Commonwealth Edison – Pilot Results

Table 4-1. Acquisition and Implementation of Free and Purchased Technology*

	Numbers			Rates	
	Offer	Acquire	Implement	Acquire	Implement
Customers Provided with Free IHDs					
L5. Basic IHD	485	485	163	100%	34%
L6. Advanced IHD	205	205	26	100%	13%
Customers Given Option to Purchase IHDs					
L5b. Basic IHD	211	5	4	2%	1%
L6b. Advanced IHD	205	4	4	2%	1%

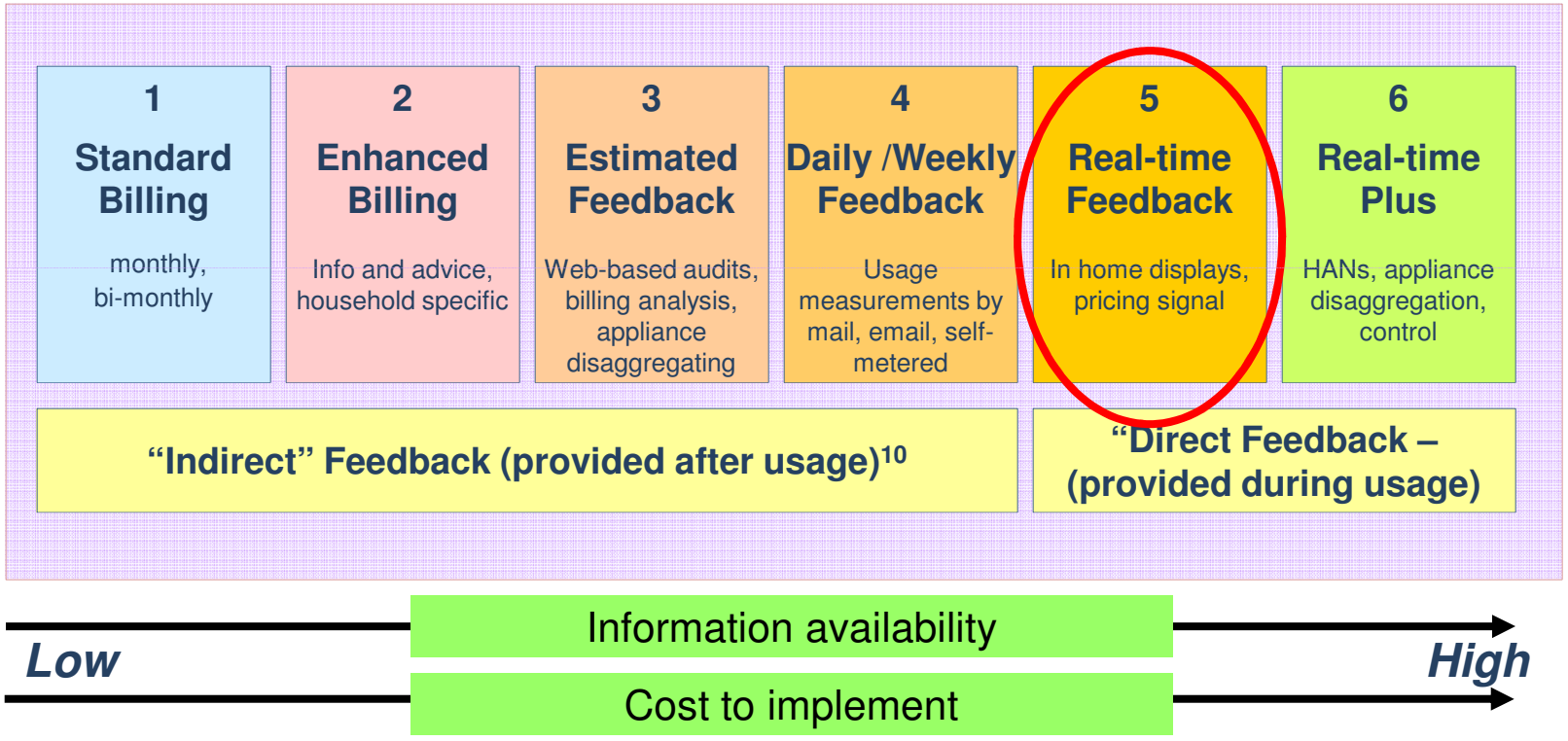
Notes:

- Basic IHD: linked to meter, continuous usage with historical comparison
- Advanced IHD: combines usage data with access to data via internet, also combined with PCT, not fully described.
- For row L5 the 34% represents the number of customers provided free IHDs that actually installed and initialized the device. For row L5b, only 2% (5/211) of the customers chose to purchase an IHD and then only 80% (4/5) of those were installed. IHD usage

* http://www.smartgridinformation.info/pdf/3273_doc_1.pdf

EPRI: Customer Information Continuum

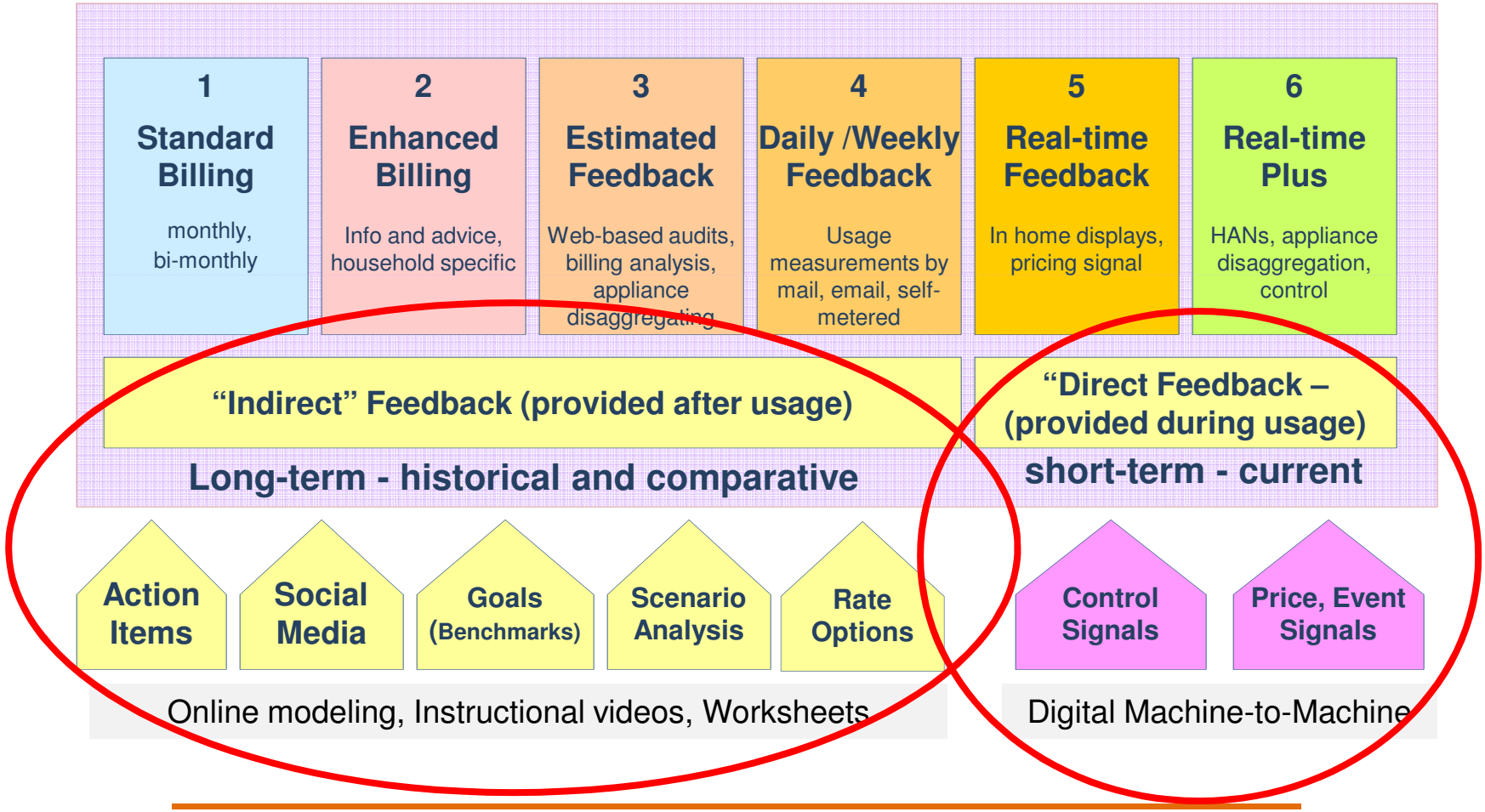
EPRI Feedback Delivery Mechanism Spectrum [1]



10. For information on new research regarding utility bill content and structure, see ACEEE report "State of the Utility Bill", Nov. 2011

EPRI: Customer Information Continuum

EPRI Feedback Delivery Mechanism Spectrum[1]



Feedback Expectations

Which Perspective is Realistic ?

"The research literature shows that in-home displays …achieving savings in the range of 5–15%.." [3]

"Consumers could cut their household electricity use as much as 12 percent …if U.S. utilities use feedback tools ..[4]

"The results show that the initial savings of 7.8% after 4 months could not be sustained in the medium- to long-term. " [1]

Real time monitors " may not be suitable tools to decrease consumption unless homeowners are presented with more information on how to conserve or a cost incentive such as TOU pricing." [6]

3 Technology Issues

Will technologies be available so customers can automate their response ?

- **Utility provided programs**
  - Can be implemented in 1-2 years
  - Limits technology options, customer choice, cost
  - May require subsidies, incentives on top of rate
- **Non-utility competitive market options**
  - Will require 3-5 years to seed the market
  - Will encourage multiple technology, service, cost, and customer choice options
  - May require subsidies or incentives to facilitate implementation and accelerate customer purchase
- **Addressing Customer Technology Concerns with Health and Privacy**

Health Concerns: Emotion vs. Science

RF Radiation levels from advanced and smart meters pose a health hazard.

- "There's no relief from these signals going through the human body."
- "Plants that grow beside Smart Meters die."
- "There is a huge body of evidence to refute the claim … that there are no effects from sub-thermal exposures"
- **" I am afraid space aliens might use them to spy on me."**

RF Radiation levels from advanced and smart meters do not pose a health hazard

- "Even if an AMI unit were to continuously operate it would still have exposures in a home far below FCC limits for the public.".. "smart meters … result in much smaller levels of … exposure than many … household … devices, … cell phones and microwave ovens."
- "Irrespective of duty cycle, ……even multiple units or banks of meters in the same location will be compliant with the public exposure limits."

Privacy Concerns:

- "Power usage within a domicile is certainly one way in which people can track whether other people are at home, whether the house is vulnerable or not."*
- If there is a consensus among consumers across the United States, it would include concerns over smart meter data privacy, the threat of identify theft, the possibility of personal behavioral patterns being recorded, and real-time surveillance reminiscent of Orwell's famous line in 1984 the "Big Brother is watching you." **
- "… it is not yet clear how expansive the information to be collected through AMI technology will become in the next few years. …the Commission [should begin] a thoughtful and thorough consideration of the rules that should govern AMI information…" ***

* Smart meters alleged to pose security risk, CBC News, October 21, 2011, http://www.cbc.ca/news/canada/british-columbia/story/2011/10/21/bc-smart-meter-privacy.html
** Smart grid data privacy: Chaos by design?, Automation Insight, May 2011, http://www.kema.com/services/ges/smart-grid/ai/smart-grid-data-privacy-chaos-by-design.aspx
*** Data privacy: Ohio ponders, Intelligent Utility, August 3, 2011, http://www.intelligentutility.com/article/11/08/data-privacy-ohio-ponders

Privacy Concerns: FIPs

Fair Information Practices*

§2. Transparency –provide notice to individuals regarding their use, disclosure, and retention of personally identifiable information (PII).

§3. Purpose Specification –seek individual consent to collect, disclose, and retain PII.

§4. Individual Participation –articulate specific purposes and uses for collecting PII,

§5. Data Minimization –collect only PII that is "directly relevant and necessary to accomplish the specified purpose(s)" and retain data no longer than necessary.

§6. Use & Disclosure Limitation: use PII only for the purposes stated in their notices.

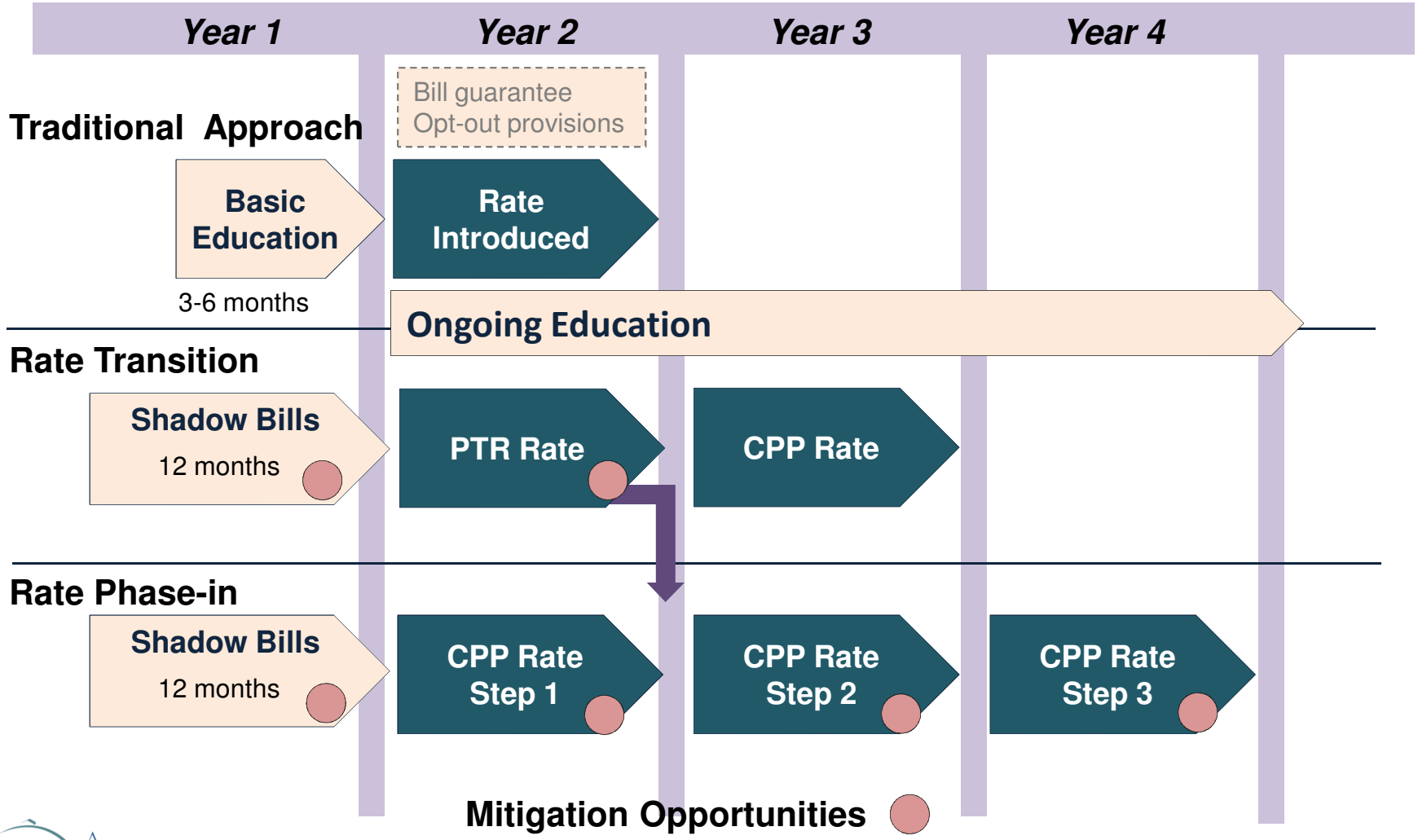
§7. Data Quality & Integrity: keep PII accurate, relevant, timely, and complete.

§8. Data Security –implement adequate safeguards to protect against loss, unauthorized use, modification, and unintended disclosure.

§9. Accountability & Auditing –audit employees' and contractors' actual use of PII, to ensure compliance with the other FIPs.

* Guide to Protecting the Confidentiality of Personally Identifiable Information (PII), NIST, April 2010, http://csrc.nist.gov/publications/nistpubs/800-122/sp800-122.pdf

4 Mitigation Options



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2. Advanced Metering Initiatives and Residential Feedback Programs: A Meta-Review for Household Electricity-Saving Opportunities, ACEEE, Martinez, Donnelly, Laitner, June 2010 https://www.burlingtonelectric.com/ELBO/assets/smartgrid/ACEEE%20report%20on%20smart%20grid.pdf
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5. Exploring consumer preferences for home energy display functionality, August 2009., http://www.cse.org.uk/pdf/consumer_preferences_for_home_energy_display.pdf
6. Neenan, B., Eom, J. January 2008. "Price Elasticity of Demand for Electricity: A Primer and Synthesis." Electric Power Research Institute, Palo Alto, CA: 2007, 1016264. Available at: www.epri.com
7. For information on the Department of Energy Smart Grid Investment Grant Consumer Behavior Study Plans, go to: www.smartgrid/gov/teams. Page down for a list of topical webinars and Guidance Documents. The Guidance Document on rate design can be found at: http://www.smartgrid.gov/sites/default/files/pdfs/rate_design.pdf
8. Levy, R., "Demand Response Best Practices, Design Guidelines and Standards", Lawrence Berkeley National Laboratory Demand Response Research Center, June 11, 2008.
9. Borenstein, S., "A Proposal for Equitable and Efficient Adoption of Opt-In Residential Dynamic Pricing", The Energy Institute at Haas, University of California Energy Institute. http://ei.haas.berkeley.edu/pdf/policy_conf/pc2011/Borenstein_CPUC_Presentation2011.pdf
10. ACEEE, State of the Utility Bill, November 2011, http://aceee.org/research-report/b111

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